

FASTER THAN FAST

If you think today's computers are powerful, think again. SU is helping to build a whole new generation of thinking machines.



In the Goldstein Auditorium, late April, a knot of reporters waited for the announcement of a new, federally supported advanced-computing center at SU. Expecting to find a row of University officials, they confronted instead a large, boxy object swathed in black fabric and lit by spotlights.

As Chancellor Melvin A. Eggers stood by, U.S. Senator Alfonse D'Amato pulled back the cloth with a flourish. Underneath was a three-dimensional Plexiglas sculpture depicting the new kinds of computer architectures that NPAC—the new Northeast Parallel Architecture Center—will make available to university, industry, and government researchers.

At either end, the sculpture showed a

single, strong square. In its inner layers, the square branched into numerous others, exquisitely integrated and eventually returning to the one. The sculpture conveyed careful fragmentation, concurrent processing, and ultimate reintegration. Today, that sculpture stands in NPAC's lobby in Link Hall, a visual reminder of the power of parallel processing.

Parallel processing. The words mean just what they suggest. Conventional computers operate sequentially, tackling computations one step at a time. Parallel computers, on the other hand, divide large computations into smaller tasks, tackling them all at once. With tens, hundreds, even thousands of processors working in tandem, the result is an enormous increase in speed. Given the right program, thorny problems that might have kept conventional computers busy for years—and humans busy for a lifetimes—can be solved in a matter of seconds on a parallel machine.

Even today, the human mind is far more

capable of performing certain simple tasks—recognizing a dog from a cat, for example—than any machine. To turn the act of recognition into a lengthy calculation, as most computers must do, is to complicate it beyond belief. But because of its phenomenal speed and flexibility, parallel processing holds out the hope of automating such complex acts as seeing, hearing, and understanding other sensory data.

Scientists at SU and all across the country hope to make it possible for computers to perform these tasks in real time—in other words, the time a human would take to perform the same action. That way, computers will be able to play a larger role in manufacturing, air traffic control, military combat—activities in which a relentless stream of facts and impressions must be processed as quickly as they occur.

“All directions lead to parallelism,” insists William Schrader, formerly executive director of the Theory Center at Cornell University and now director of NPAC. But

parallel machines are new, and most of them are untested. Schrader explains that NPAC, which will be housed in the new Science and Technology Center, brings together under one roof as many different parallel architectures as possible. The goal is for researchers to put each one through its paces, speeding the process of bringing parallel processing into routine use.

That is how NPAC is designed to work. Eventually, as many as six different parallel computers may be on-site. NPAC researchers experimenting with the machines and their differing capabilities will define everyday applications suitable to them.

"NPAC will enable us to develop real tools for solving real problems," says Schrader.

"Furthermore," adds Karen Hiiemae, vice president for research and graduate studies, "existing relationships with the corporate sector and with government research facilities such as the Rome Air Development Center will be strengthened. Over the long term, we expect the result of this relationship to be expanded technology transfer and enhanced economic development in the Syracuse region and throughout New York state." Like the CASE Center, NPAC will become a vital arena for collaborative research.

"NPAC is expected to become an important test site for new architectures as they are developed," says Carole Barone, vice president for information systems and computing. "The center will give students access to a wide array of leading-edge technologies."

Through the efforts of Senator D'Amato, a Syracuse alumnus, the federal government has made available to SU \$12 million to provide the capital investment needed to establish the center. Syracuse has submitted a proposal to the Defense Advanced Research Projects Agency for operating funds for NPAC for a five-year period.

Sequential processing, not parallel processing, has defined computing for the last 40 years, ever since John von Neumann, a Hungarian-born emigre to America, developed the first computer. An enormous machine housing miles of wire, its central processing unit was connected to its

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memory by a single electronic pathway. Such an architecture, though effective, ensured that only one instruction could be processed at a time.

Since then computers have become smaller and speedier, as silicon chips have replaced vacuum tubes and transistors, but most computers still embody von Neumann's basic design. Computer architects, limited by the speed at which electrical impulses can travel along that single pathway, have discovered that the only way to overcome "von Neumann's bottleneck" is to harness the power of more than one processor.

Parallel computers do just that. Some, called "coarse-grained," combine a small number of high-powered processors and work by dividing complicated programs into separate parts that can run concurrently. Others, dubbed "fine-grained," bring a huge number of weak processors to bear on vast amounts of data, performing the same simple operation on each. NPAC offers researchers access to both types of architecture.

The Encore Multimax, NPAC's first pur-

chase and a coarse-grained machine, puts 18 massive processors to work at once. A straightforward machine with a Unix-based operating system, the appeal it holds out to SU's researchers is its incredible horsepower. "In a raw computing sense," observes Ernest Sibert, professor of computer and information science, "the Multimax is nearly a match for all the other computers on campus." The Multimax is partially compatible with traditional computers; it runs some existing programs and poses less of a hurdle to software engineers than more complicated approaches to parallel design. Its huge shared memory means that many users can tap into it at once.

The other machine purchased so far—Thinking Machine Corp.'s Connection Machine—is a fine-grained machine with very different strengths. Its 32,000 tiny processors, each with its own memory, are not nearly so powerful as the Multimax's 18 processors, but overall the machine is better suited to digesting large amounts of data. With the help of a front-end machine such as a Symbolics LISP machine, the Connection Machine assigns each separate piece of data to its own processor and then performs the same operation on each one, all in the blink of an eye.

University Professor J. Alan Robinson, for one, is excited about the prospect of implementing SUPER, the computer language he is developing with postdoctoral researcher Kevin J. Greene, on the Connection Machine. "We want to know what happens when hundreds of thousands of small processors simultaneously compute their own small portion of a large problem," Robinson explains.

"Our main hope," adds Greene, "is that we'll get a tremendous increase in speed."

They can hardly fail. Ever since Thinking Machine Corp. launched the Connection Machine last year, users have been dazzled by its ability to make short work of such complicated applications as very large scale integrated circuit design, image processing, and fluid modeling. When Dan Pease, assistant professor of electrical and computer engineering, used it to search a data base of 40,000 different documents, it responded not in days or hours but in seconds.

—B.A.